EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN-PPE/91-168
03.10.91

THE CONTROL SYSTEM OF THE CERN-ISOLDE ON-LINE MASS-SEPARATOR FACILITY

O.C. Jonsson, O. Borch[1], A. Bret, R. Catherall, I. Deloose, G.J. Focker, D. Forkel, E. Kugler, G. Olesen, A. Pace, H.L. Ravn, C. Richard-Serre[2], G. Shering, O. Tengblad, H.J. Torgersen[3]

and the ISOLDE Collaboration

CERN, ISOLDE, CH-1211 Geneva 23, Switzerland
1) Institute of Electronic Systems, Aalborg University, DK-9220 Aalborg, Denmark
2) IN2P3, Paris; permanent address: CERN
3) Department of Chemistry, University of Oslo, N-0315 Oslo, Norway

ABSTRACT

With the move of the ISOLDE-facility to the PS-Booster from the now closed Synchro Cyclotron at CERN, a new control system will be implemented for the two separators. Personal computers, based on the Intel 80386 micro processor running under MS-DOS and Microsoft Windows are used. Network-wide distributed front end computers, which access the hardware for controls and measurements, are controlled by PC-consoles via a local area network with a PC file server used as a data base.

To be presented at the Twelfth International Conference on Electromagnetic Isotope Separators and Techniques Related to their Applications (EMIS12)
Sendai, Japan, 2-6 September 1991
To be published in Nucl. Instrum. & Methods B

1. Introduction

In connection with the transfer of the ISOLDE on-line mass-separator facility (IS-2 and IS-3) [1,2] to the PS-BOOSTER from the now closed Synchro-Cyclotron, a complete redesign of the control system is being undertaken. The IS-3 separator [3,4] will be moved with most of its existing hardware, whereas in the case of the IS-2 separator rather its concept will be moved. The IS-2 separator was controlled with analog devices and only the lenses and the deflectors of the beam lines were computer controlled [5]. At IS-3 the existing control system [6] was installed in 1985 and is based on CAMAC to control the separator. It did not, however, control the external beam lines because of lack of money. The new control system [7,8], which will control the two separators and the beam lines in the experimental areas, is compatible with the old CAMAC hardware and software, and allows an evolution of the system towards modern solutions.

2. The Control System Architecture

The ISOLDE control system [9], shown in fig. 1, consists of Personal Computers (PC's), with Intel micro processors running under MS-DOS or Microsoft Windows. Network-wide distributed PC's as Front End Computers (FEC's), which access the hardware for controls and measurements, are controlled by PC-consoles via a local area network with a PC file server used as a data base. The general purpose Ethernet network available all over CERN is used.

3. The File Server

The ISOLDE file server is a 80386-based, 25 MHz, Olivetti PC with a 300 MBytes hard disk running a commercial PC networking product from Novell called Netware. This network provides a shared file system, shared printers, computer to computer and computer to server communications that are used in the control system to share data bases, application programs and hardware equipment between different consoles. It also permitted the ISOLDE control system to inherit all the security features that the Novell network provides.

4. The Front End Computers

The PC's controlling the hardware are called Front End Computers (FEC's). They are mainly Olivetti 386/25 machines, but also some IBM AT computers with an 80286 CPU are used. The performance of these machines is for the moment fully satisfactory. The connections to the hardware are made via the CAMAC and the GPIB instrumentation buses or by PC/AT cards plugged directly into the PC mother bus as well as in ad hoc extension chassis. Thus, the kind of control/acquisition boards in use are:

PC - CAMAC interface cards, because a wide range of standard modules is available and in order to allow the recuperation of the hardware from the IS-3 control system.

PC - GPIB interface cards, a commonly used bus for measuring instruments also known as the IEEE-488 bus.

PC/AT cards, for "direct" interfacing to the equipment. The types of these cards are for the moment Analog to Digital Converter boards (ADC's), Digital to Analog Converter boards (DAC's), Digital Input and Output boards (DIO's) timer and external interrupt boards, and RS232 boards.

The vacuum control system has still lower level computers between the FEC and the equipment. These are Programmable Logical Controllers (PLC's) from Siemens which handle the vacuum control and its security. E.g. close the vacuum valves if pressure becomes to high, inhibit the opening of the vacuum valves via the FEC for the same reason, start and stop pumping a given section, etc.

The number of devices to be controlled is on the order of 300 with about 1700 control channels (analog or digital wires) coming into the control system, distributed in 8 different FEC's.

All Front End Computers run NODAL [10] for MS-DOS. A program, FEC NODAL, that provides a network listener to execute Remote Procedure Calls coming from the different consoles has been developed and a local NODAL interpreter is used to locally check the connected equipment.

The connection between hardware and software is made by so called Equipment Modules (EM's). They are C subroutines linked with the FEC NODAL program, accessible from any PC connected to the CERN Ethernet, and treated as a function by the NODAL language. Every Equipment Module has a data table with computer addresses and equipment specific values that are stored and maintained in the equipment data base on the file server. These hardware specific EM's give each FEC a different software configuration, which is loaded from the file server together with the data table at the start up of the FEC.

5. The Consoles

The consoles in the control room are also Olivetti 386/25 machines. PC's with a 80486 CPU may be introduced later. The console computers are equipped with 21 inch colour monitors giving a resolution of 1024 x 768 pixels. Besides the high resolution monitors, the consoles are fully compatible with all 386-based PC's available in the offices as local workstations. The consoles, as well as the office PC's, run Microsoft Windows.

The application programs are written using the C language or using any development tool that supports Windows native Dynamic Data Exchange (DDE) protocol. The high level tool chosen for that purpose is Excel, a program from Microsoft, that provides the data-base to store all data and parameters. The system is entirely database driven using Excel and the only "hardcoded" data in the application programs are the names of the elements to control. All the rest, like node addresses on the network, in the computer and in the CAMAC modules, etc., is taken from the data base. This keeps the system maintenance to a strict minimum. Excel also provides a spreadsheet to calculate and display physical parameters of the separator, graphic facilities to summarize several parameters in one single chart and a powerful macro language to write end-user applications used by the operation team. The interaction with the devices to be controlled is done using pull down menus, dialog boxes and push buttons. Access to the equipment over the network is done using DDE requests. These are then captured by an "ad hoc" program that translates the demand into a network Remote Procedure Call to the FEC connected to the equipment in question. Fig. 2 shows an example of an application written in C using the Windows Software Development Kit, while fig. 3 shows an application written using Excel Macros and the DDE protocol.

6. Control System Characteristics

6.1 Integration

The ISOLDE control system, although completely independent in case of problems, is transparently integrated in the PS Office Network. Development of control applications is possible from any office without the installation of additional hardware. All connected laser printers (A3/A4, black and white or colour), plotters, scanners, disks, software and data of the office network, including its support, are available. By relying on this infrastructure, the information can easily be distributed CERN-wide as electronic logbooks.

6.2 Simplicity

Using the same type of computer (PC compatible) at all levels (console- and FEC level) of the control system makes it conform to the same standard. There is the advantage that the same operating system is used for the consoles and for the office machines. A uniform system like this reduces the skill necessary to cope with different parts of the control system as the approach is always the same; all the programs are data-driven from an Excel Database.

6.3 Software development

The use of well tested software products has reduced the development to a strict minimum. The few necessary developments done with the available tools have shown that:

- Development is fast and easy because of the user friendliness of the tools available with the Microsoft Windows Software Development Kit (SDK), the Microsoft C - and QuickC -compiler; for example the dialog editor, the debugger and the SDK paint programs.
- Specific computer skills are not necessary; physicists and equipment users can write their own programs after very little training using interpreted languages as Nodal, Excel Macro Scripts or QuickC.

6.4 Speed

The speed of a control system is often limited by the network used. The Novell network, based on Ethernet, has a performance of more than 100 kBytes/sec transfer rate on the busy CERN Ethernet. A typical Remote Procedure Call, with a search in the element data base to find which FEC and which equipment module to call, takes less than 30 milliseconds. The total speed of the control system could be further improved by using only 386/25 machines as FEC's and for time-critical applications even Intel 80486 based, 33 MHz, machines could be envisaged. The latter would be used as high performance consoles.

7. Conclusion

The ISOLDE Control System is a low cost, high performance system, built up from industry standards. Based on a world wide market of 60 millions machines per year, with binary compatibility, from many different manufacturers in competition, the system is not expected to become obsolete for at least the next 10 years. And as the speed of a PC increases with a factor of two every year, a change to the next generation of micro processors will make the system even faster.
Furthermore, there is no limit to the number of control channels the system can handle. If necessary, more FEC's and consoles can conveniently be added.

8. References

[1] E.Kugler et all, these Proceedings (EMIS-12) Nucl. Instr. and Meth.

[2] H.L.Ravn, Phys. Rep. **54** (1979) 201

[3] B.W.Allardyce and H.L.Ravn, Nucl. Instr. and Meth. **B26** (1987) 112

[4] C.Geisse, H.Wollnik, B.Allardyce, E.Kugler and K.Schloesser, Nucl. Instr. and Meth. **B26** (1987) 120

[5] O.C.Jonsson, ISOLDE-2 Beam Adjustment System, User Guide, Internal Report 1984

[6] H.D.Lustig, G.P.Benincasa and C.Richard-Serre, Nucl. Instr. and Meth. **B26** (1987) 51

[7] A.Pace, The ISOLDE Control System Reference, PS/OP/Note 91-17

[8] A.Bret, I.Deloose, A.Pace and G.Shering, The ISOLDE Control System, PS/OP/Note 91-27

[9] R.Billinge, A.Bret, I.Deloose, A.Pace and G.Shering, A PC based Control System for the CERN ISOLDE Separators, To be published in the Proceedings of the International Conference on Accelerators and Large Experimental Physics Control Systems, Tsukuba, Japan, 1991

[10] M.C.Crowley-Milling and G.C.Shering, The NODAL System for the SPS, CERN 78-07 SPS

FIGURE CAPTIONS

Fig. 1 The ISOLDE Control System Architecture

Fig. 2 Example of a synoptic and of some control panels

Fig. 3 Example of a control application developed with Excel

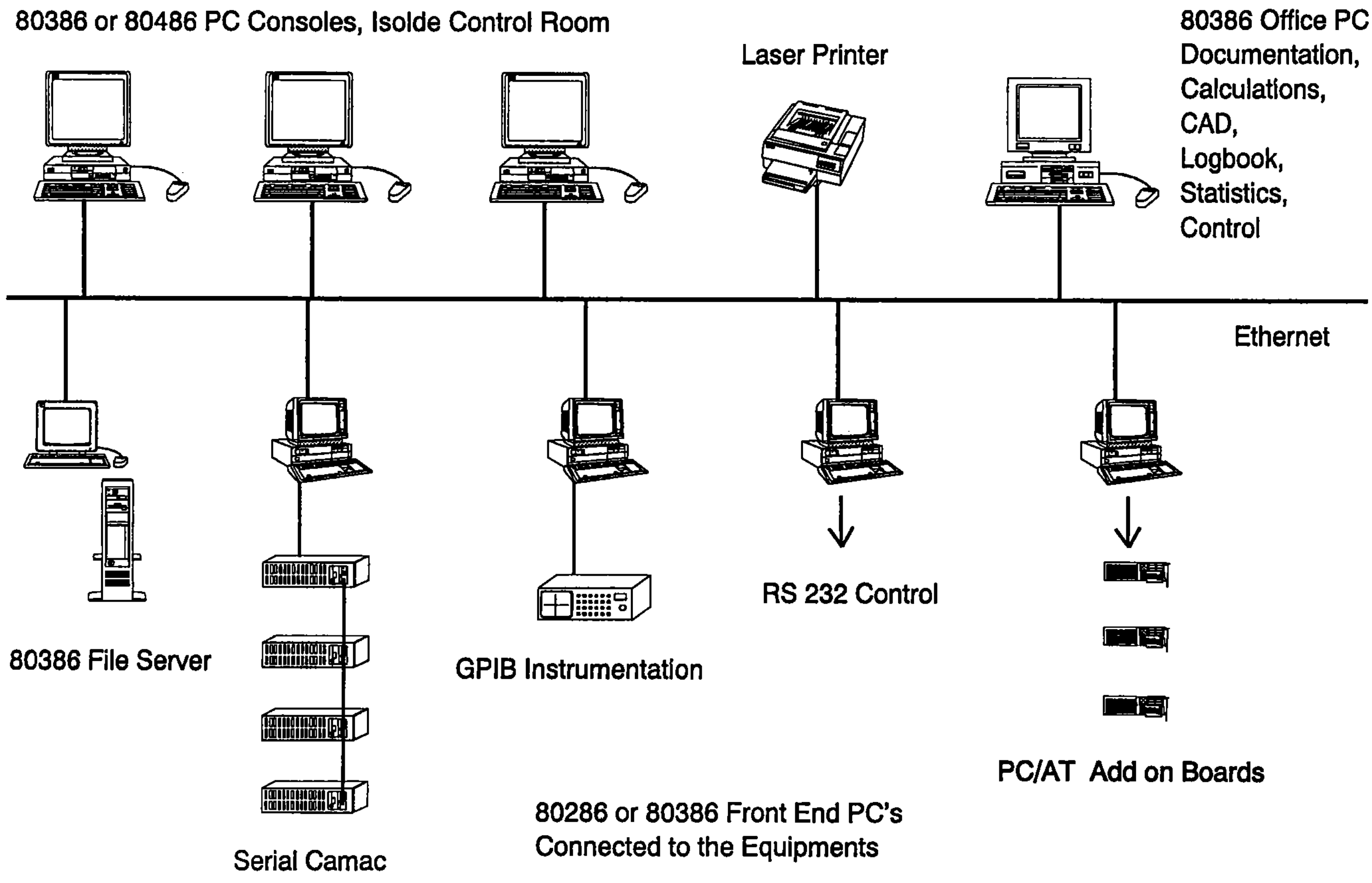
80386 or 80486 PC Consoles, Isolde Control Room
Laser Printer
80386 Office PC
Documentation,
Calculations,
CAD,
Logbook,
Statistics,
Control
Ethernet
80386 File Server
Serial Camac
GPIB Instrumentation
RS 232 Control
PC/AT Add on Boards
80286 or 80386 Front End PC's
Connected to the Equipments

fig. 1

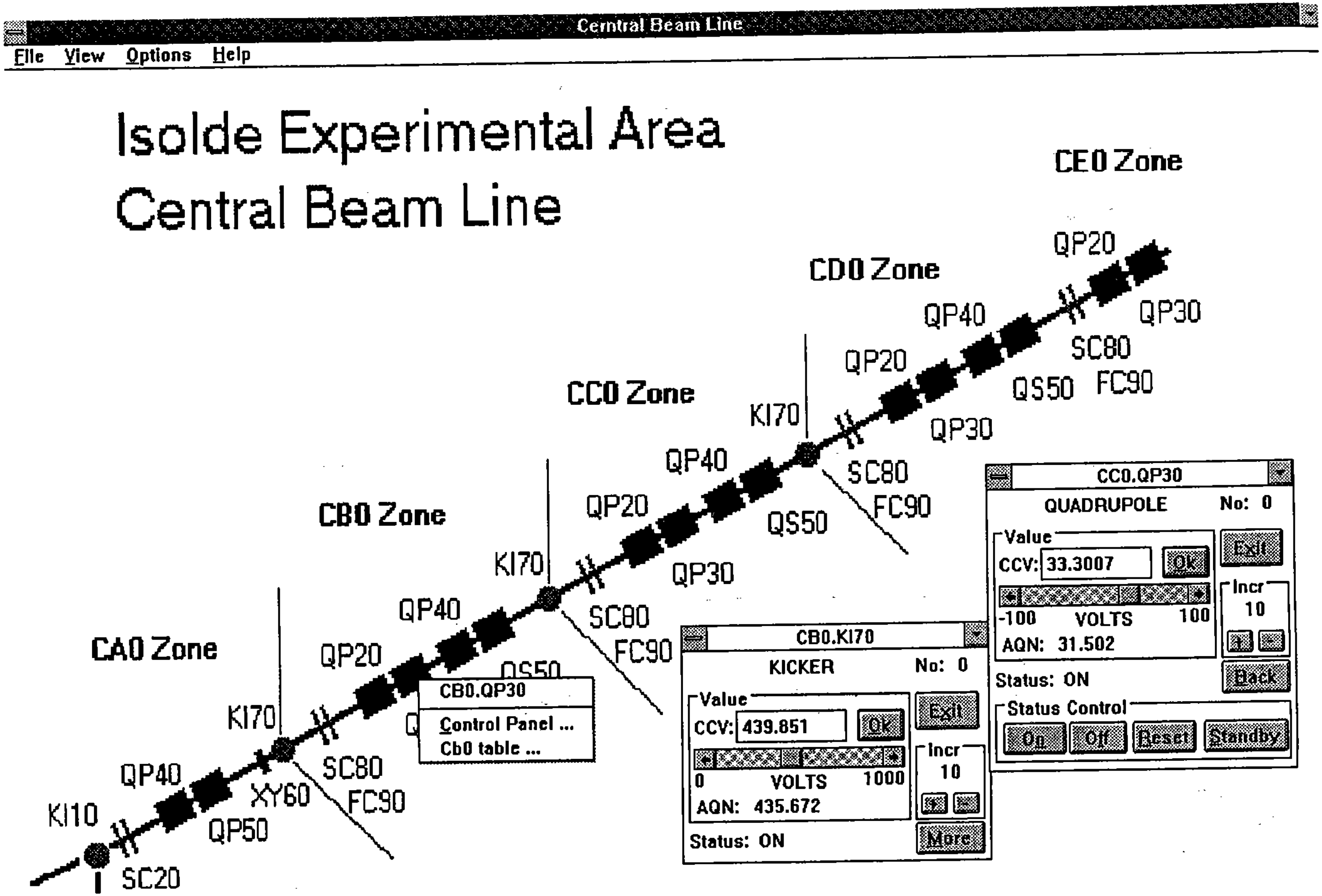
Cemtral Beam Line
File View Options Help
Isolde Experimental Area
Central Beam Line
CA0 Zone
CB0 Zone
CC0 Zone
CD0 Zone
CE0 Zone
KI10
SC20
QP40
QP50
XY60
KI70
SC80
FC90
QP20
QP40
QS50
KI70
SC80
FC90
QP20
QP30
QP40
QS50
KI70
SC80
FC90
QP20
QP30
QP40
QS50
SC80
FC90
QP20
QP30
CB0.QP30
Control Panel ...
Cb0 table ...
CB0.KI70
KICKER
No: 0
Value
CCV: 439.851
Ok
0
VOLTS
1000
AQN: 435.672
Status: ON
Exit
Incr
10
More
CC0.QP30
QUADRUPOLE
No: 0
Value
CCV: 33.3007
Ok
-100
VOLTS
100
AQN: 31.502
Status: ON
Exit
Incr
10
Back
Status Control
On
Off
Reset
Standby

fig. 2

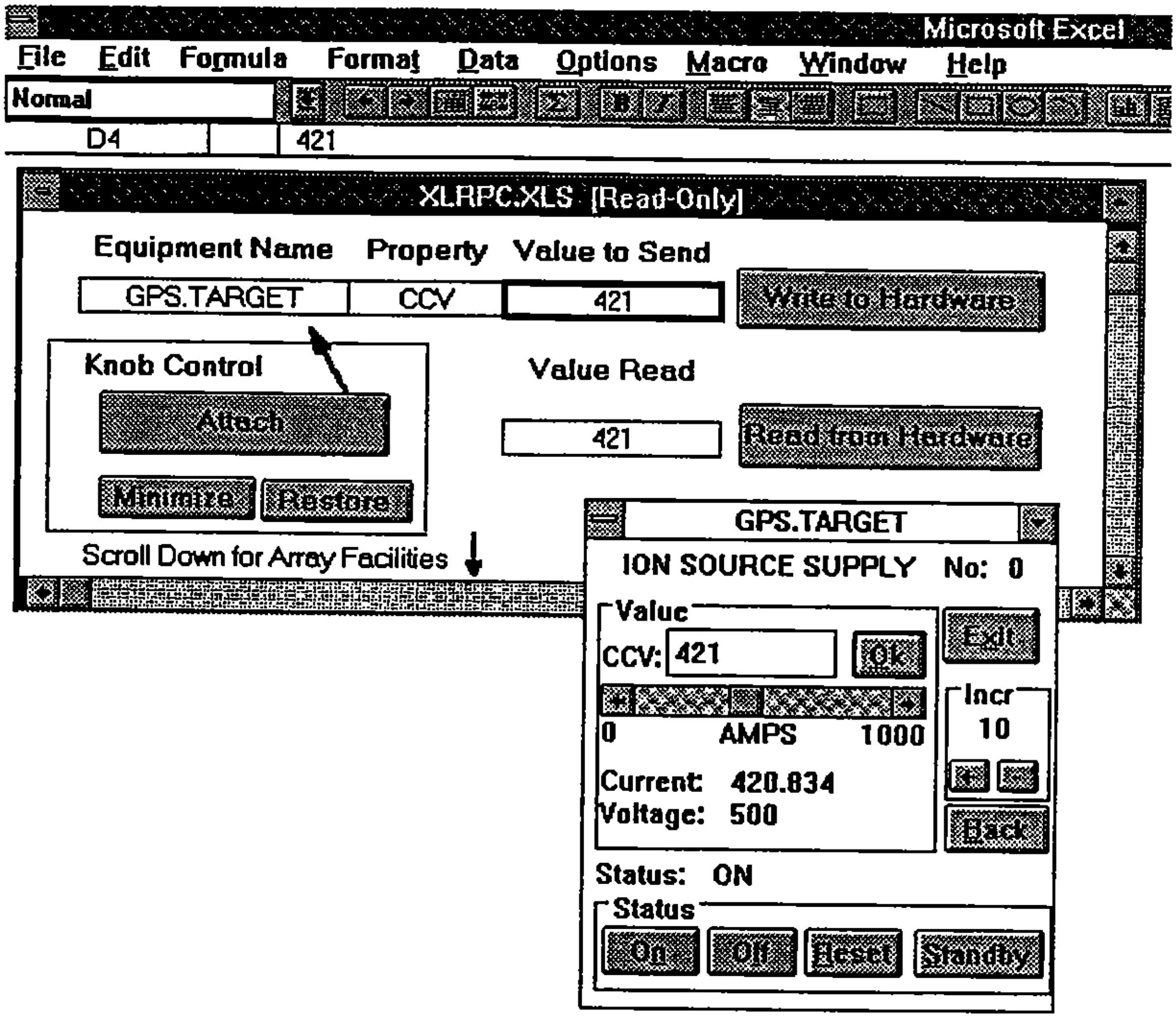

fig. 3

Imprimé au CERN. Prix: 0.35 Fr.